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A unique engraved shale pendant from the site of Star Carr: the oldest Mesolithic art in Britain

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Summary

In 2015 an engraved shale pendant was found during excavations at the Early Mesolithic site of Star Carr, UK. Engraved motifs on Mesolithic pendants are extremely rare, with the exception of amber pendants from southern Scandinavia. The artwork on the pendant is the earliest known Mesolithic art in Britain; the 'barbed line' motif is comparable to styles on the continent, particularly in Denmark. When it was first uncovered the lines were barely visible but using a range of digital imaging techniques it has been possible to examine them in detail and determine the style of engraving as well as the order in which the lines might have been made. In addition, microwear and residue analyses were applied to examine whether the pendant showed signs that it had been strung or worn, and whether the lines had been made more visible through the application of pigments, as has been suggested for some Danish amber pendants. This approach of using multiple scientific and analytical techniques has not been used previously and provides a methodology for the examination of similar artefacts in the future.

1. Introduction

During the 2015 excavation season at Star Carr (Figure 1), a shale pendant with lines engraved into it was found in the lake edge deposits. When the artefact was first uncovered it was thought to be a natural piece of stone: the perforation was full of sediment and the engravings were not visible. On lifting, the sediment fell away from the hole and on closer inspection, faint engravings became visible on one side.



Figure 1: Photograph of the pendant showing the faint engravings.

Although shale beads, a piece of perforated amber, bird bone and two perforated animal teeth have been recovered from Star Carr (Clark 1954; Milner *et al.* 2013a), this latest discovery represents the first perforated artefact with an engraved design. The art is typical for this period, in its geometric design associated with small portable objects (Płonka 2003). Other pendants are known from northern Europe, in particular, Denmark (Fischer and Vang Petersen forthcoming; Toft and Brinch Petersen forthcoming; Vang Petersen forthcoming), but an engraved pendant is unique for Britain. Furthermore, to our knowledge, no other Mesolithic engraved pendants from Europe are made of shale: the predominant material used being amber, antler and bone (Andersen 2001; Gramsch 2014); however, an engraved stone pendant has been found from Brunstad, Norway (Schülke 2015).

Grahame Clark, the original excavator at Star Carr (Clark 1954) did not find any engravings like this at the site. He was, however, an expert on the art found in Europe and wrote a comprehensive chapter on the art of the Maglemose culture (the Early Mesolithic) in his book on the Mesolithic settlement of Northern Europe (Clark 1936). It is therefore unfortunate that the engraved pendant was found less than a metre from the end of Clark's Cutting II (Figure 2), in that he did not have the chance to study this piece. The area where the pendant was discovered is where Clark found a large quantity of bone, antler and wood, including rare artefacts such as 21 headdresses made from red deer skulls and 191 antler barbed points; the pendant

appears to be from the same detrital muds and is therefore broadly associated with these other finds (Figure 2).



Figure 2: Location of the find. The detail of Clark's excavations is taken from the plan as published in the 1954 monograph with details of the birch tree and 'birch brushwood platform' associated with a large quantity of bone, antler and flint. The gap in Clark's plan of the brushwood is an area which was not planned but which also contained these finds, and similarly, much of the rest of Clark's excavation produced large quantities of material but plans for this area do not exist.

The small size of the pendant and the faint nature of the artwork necessitated the application of a range of techniques in order to gain high resolution imaging for a better understanding of the creation of the lines: Reflectance Transformation Imaging (RTI), white light 3D scanning, light microscopy, and scanning electron microscopy (SEM). The pendant has been examined under low and high power microscopes for use-wear traces which might indicate whether it had been strung or used. It has also been suggested by Clark (1936, 162, footnote 1) that patterns on such objects may have been made visible by rubbing in a darker substance 'as is done by Esquimaux in rather similar incised bone-work' and it has been noted that black birch bark pitch was used to infill the designs of the Danish amber pendants (Toft and Brinch Petersen forthcoming; Vang Petersen forthcoming), as well as antler and bone (Malmer and Magnusson 1955). Therefore, we have examined the artefact for *in situ* organic residues using reflected light microscopy and Micro-Raman spectroscopy.

This paper presents the results of these investigations and places the pendant into the wider context of European Mesolithic portable artwork. Finally, we examine our data in order to produce a biographical account of the uselife of this object which saw it being deposited, perhaps ritually, in the water at the lake edge.

2. Background to the site

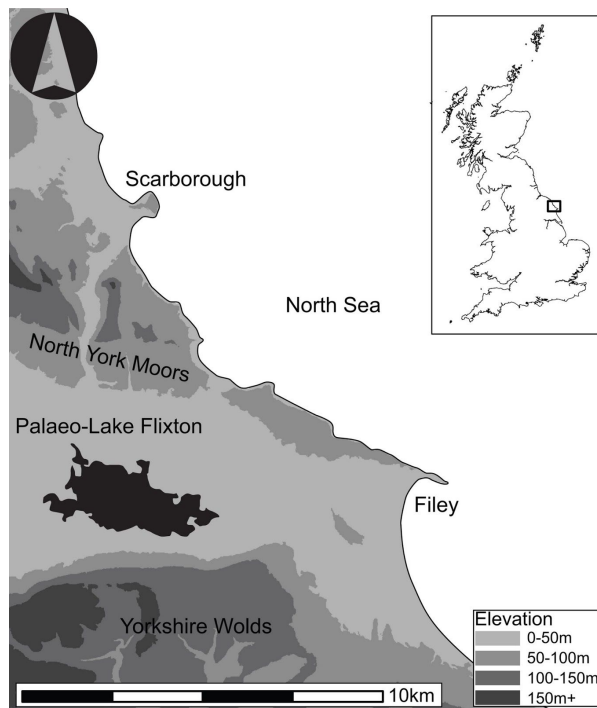


Figure 3: Location map of Star Carr: Star Carr was found on what would have been the edge of a lake, now known as palaeo-lake Flixton.

Star Carr is one of a number of Early Mesolithic sites that have been recorded around palaeo-Lake Flixton, in the eastern Vale of Pickering, North Yorkshire, UK (Figure 3). The palaeo-lake formed at the start of the Windermere Interstadial (c. 12,700-10,800 cal BC), a warm phase at the end of the last Ice Age, and it persisted as a water body until the end of the Mesolithic (c. 4000 cal BC).

John Moore, a local amateur archaeologist, first carried out investigations in the area from 1947 (Clark 1954, xvii) and identified 10 sites around the lake. Moore excavated a trench at Star Carr in 1948, and from 1949-1951 Grahame Clark from the University of Cambridge conducted three further seasons of fieldwork (Clark 1954). Further work in the area has been carried out since the 1980s by the Vale of Pickering Research Trust in order to map the extent of the lake and discover further sites (Milner *et al.* 2011). Since 2004, NM, CC and BT have been co-directing excavations at Star Carr (Conneller *et al.* 2012; Milner *et al.* 2013b). In 2012 the POSTGLACIAL project commenced: this is a five year, European Research Council

funded project aiming 'To implement an interdisciplinary, high-resolution approach to understanding hunter-gatherer lifeways within the context of climate and environment change during the early part of the post-glacial period (c. 10,000-8000 BC)'. In order to address this aim, excavations have been carried out at Star Carr over three seasons from 2013-2015.

3. Description of the pendant

The pendant was found within context 317, a brown-green fine detrital mud containing a high proportion of organic material within the matrix. The contexts are currently being dated and modelled using Bayesian statistics by Alex Bayliss (Historic England) but at present it is possible to say that these sediments formed at around 9000 cal BC. The pendant was deposited into shallow water, at least half a metre deep and approximately 10m from the lake shore. Reeds, sedges, and a suite of aquatic plants were all growing in the immediate area, forming a species rich swamp environment.

The pendant is sub-triangular in shape, measuring about 31mm by 35mm and 3mm thick (Figure 4). ED-XRF (energy-dispersive x-ray fluorescence) analysis was carried out to confirm whether it was made of shale (Rowley and Needham 2015). Element concentrations were measured using an Olympus Delta Portable ED-XRF Analyzer. The elemental composition data was compared with that published in Rowe *et al.* (2012) and can be demonstrated to be consistent with the composition of shale.

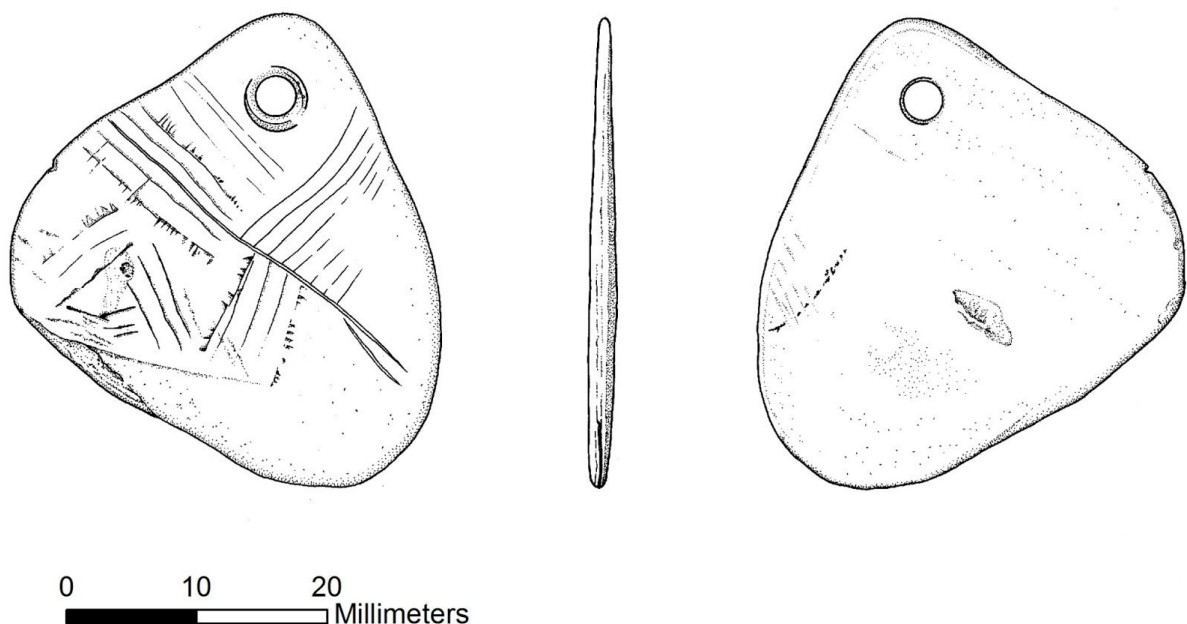


Figure 4: Illustration of the pendant (by Chloe Watson).

Unfortunately, the artefact sustained damage from troweling towards the base of the engraved surface. These marks appear as light scratches and are easy to differentiate from the fine engraved lines. The stone is fragile with the potential to laminate, hence much care has been taken when handling it, and powder free nitrile gloves were worn to avoid contamination in advance of residue analysis.

There is a perforation in one of the vertices that has been made by drilling through from the engraved side of the pendant. The engravings only appear on one side and the lines are very faint: the smallest lines are hard to distinguish from one another with the naked eye. The artwork uses the incision method which is the most common and least specialised of Early Mesolithic artwork, the other types being pricking and drilling to create dots (Clark 1936). Most of the lines can be classified as linear and in Clark's terminology barbed lines of 'type C', i.e. lines which come off another line at right angles (Clark 1936, 169).

On the reverse side to the engraving there is a nick caused by a missing flake of shale in the central region, shown clearly from the laser scan of the artefact (Figure 5). This may have happened accidentally or intentionally, presumably by something hard striking this surface before it was deposited in the lake.

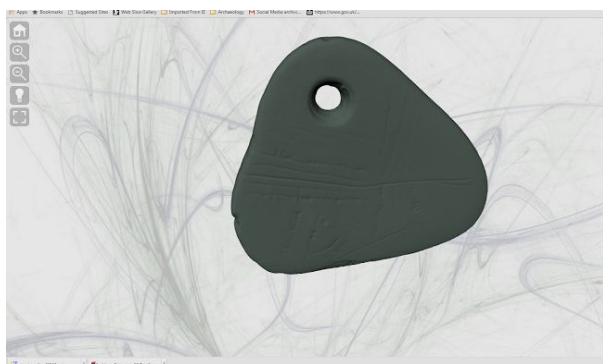


Figure 5: A laser scan of the pendant which clearly shows the missing flake on the unengraved side of the pendant. [INTERACTIVE SCAN TO GO HERE THAT THE READER CAN ROTATE](#)

This artefact is being termed a 'pendant' because the perforation is not central, implying that it may have been suspended and worn as a necklace. The other perforated shale objects at the site were defined as 'beads' by Clark since the perforations are more or less central, the only exception being the 'celtiform bead' (Clark 1954, 165) which could in fact also be classified as a pendant (Figure 6). It is unclear how the shale beads from Star Carr were worn: whether they were items of jewellery or perhaps appliqués (Cristiani *et al.* 2014a; Langley and O'Connor 2015). Further use-wear analysis on these other beads is planned, and will aim to address this question. Of the three pieces of amber found, one was classified as a pendant; this piece has 2 holes at the top (Figure 7) (images of most of the finds from the

original excavations by Clark can be found in the Archaeology Data Service Star Carr Archives Project: (Clark 1954; Milner *et al.* 2013a).



Figure 6: The shale beads from Star Carr and the 'celtiform bead' at the top, (Museum of Archaeology and Anthropology, Cambridge, accession number: 1953.72).



Figure 7: The perforated amber pendant (Museum of Archaeology and Anthropology, Cambridge, accession number: 1953.70).

In the 2015 excavation, two further shale beads were discovered which are typical of the majority of beads found by Clark. What is noteworthy is that these beads were not found in the same context as most of the other archaeological material that Clark excavated. Instead they were recovered from the wood peat which dates to approximately 100 years later than the phase to which the engraved pendant and the headdresses belong. Although Clark (1954, 19) plotted the spatial distribution of

many of the artefacts from his excavations in his monograph (see Figure 8), the depths were not recorded and the archive appears to have been destroyed (Milner *et al.* 2013a). From our current understanding of the stratigraphy and typology of the artefacts, it is likely that the small shale beads are later in date than the engraved shale pendant. It is always possible that the amber pendant and celiform shale pendant were contemporary with the engraved pendant; however, as there is no contextual information for those finds, this hypothesis will remain unresolved.

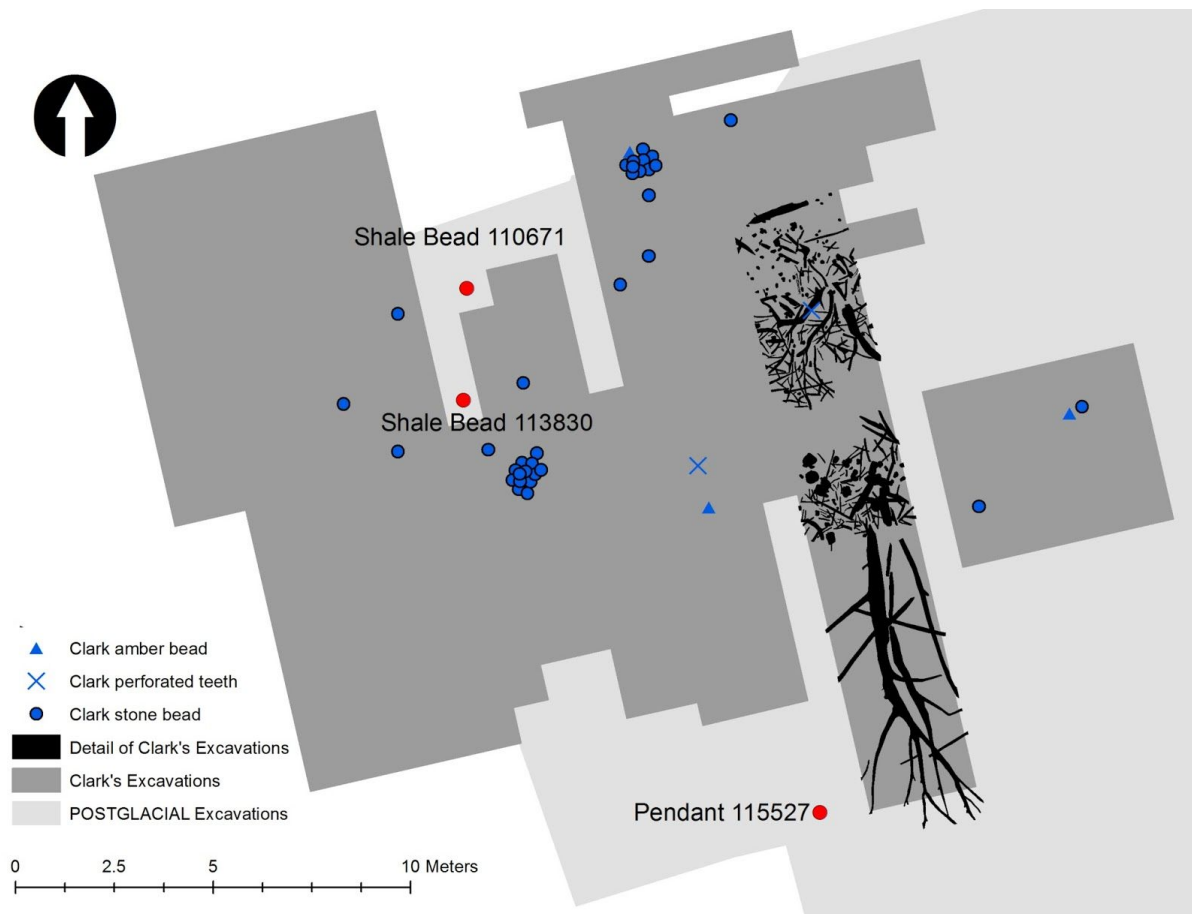


Figure 8: Location of the find in relation to Clark's artefacts. The two shale beads marked on the plan as red, were also found in 2015 within a later context than the majority of Clark's other finds and the engraved shale pendant.

4. Analysing the engravings

4.1. Methods

A number of imaging methods have been employed to assess the direction of the lines, to understand their relationship to each other, and the line order and phasing. To do this we integrated light microscopy, reflectance transformation imaging (RTI), white light 3D surface scanning, and scanning electron microscopy (SEM).

Light Microscopy was used but was limited to low power light microscopy, using a stereoscope with 10x to 100x magnification. The shallowness of the engravings presented a challenge for assessing the line order, but this was further compounded by the presence of highly reflective gold coloured iron pyrite crystals adhering to the surface (see below), which made analysis with conventional light microscopy challenging; the fixed and direct light source making the engravings virtually invisible. This is a common problem when analysing shallow engraving on stone surfaces, thus digital methods are increasingly advocated as alternatives to or as methods to be used in tandem with microscopy (Bello *et al.* 2013; Fritz 1999; Fritz and Tosello 2007; G  th 2012; Tosello and Villaverde 2014).

In contrast, SEM, a non-light based technique, yielded significantly better results on this surface. The reflection from the gold coloured particles was immediately removed by the SEM, making line order relationships far easier to recognise and analyse. A Hitachi TM3030Plus tabletop scanning electron microscope (SEM) was used to image key details of the engraved lines (Figures 9, 10 and 11). This piece of equipment was chosen over other SEM options since it is nondestructive to artefacts. No sputter-coatings (such as gold, carbon, palladium) are required for imaging using this SEM; a major advantage to traditional high vacuum SEM analysis. SEM images were collected in secondary electron mode and backscattered electron mode and from 25x to 3000x magnification.

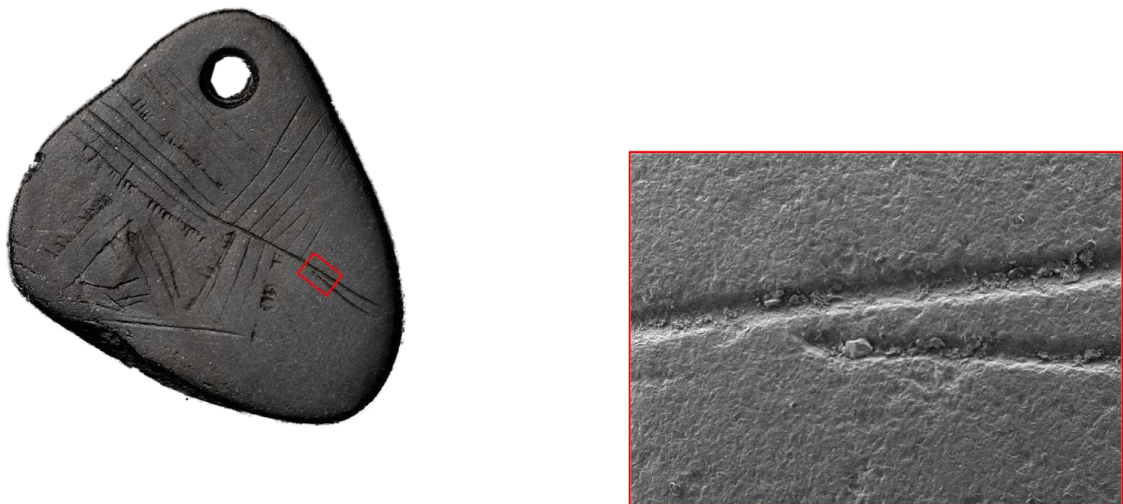


Figure 9: An example of an image taken with SEM demonstrating that two lines do not meet. It is also possible to assess the direction that the incision was made, with working from left to right in this instance. Image captured at 50x magnification using secondary electron mode.

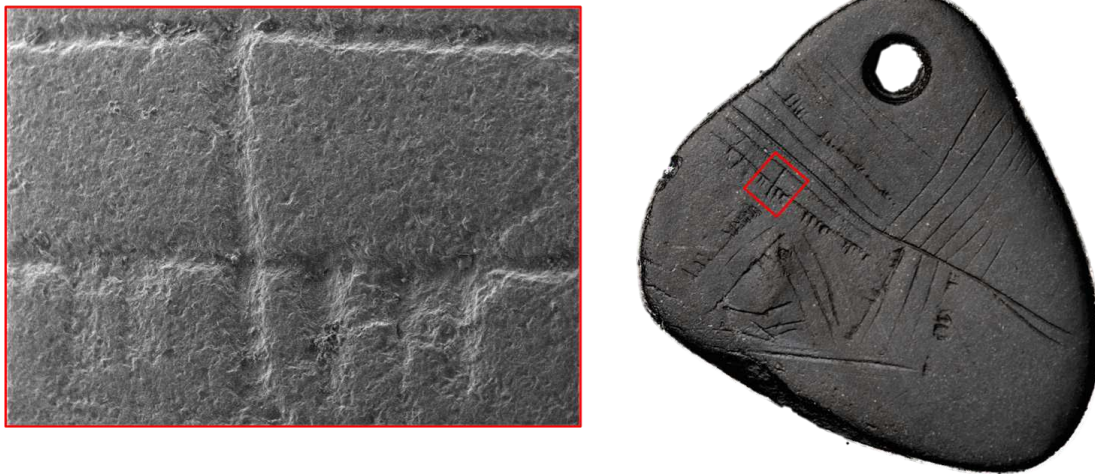


Figure 10: SEM image showing the precision of the short lines which have been incised at right angles from a longer line. Image captured at 50x magnification using secondary electron mode.

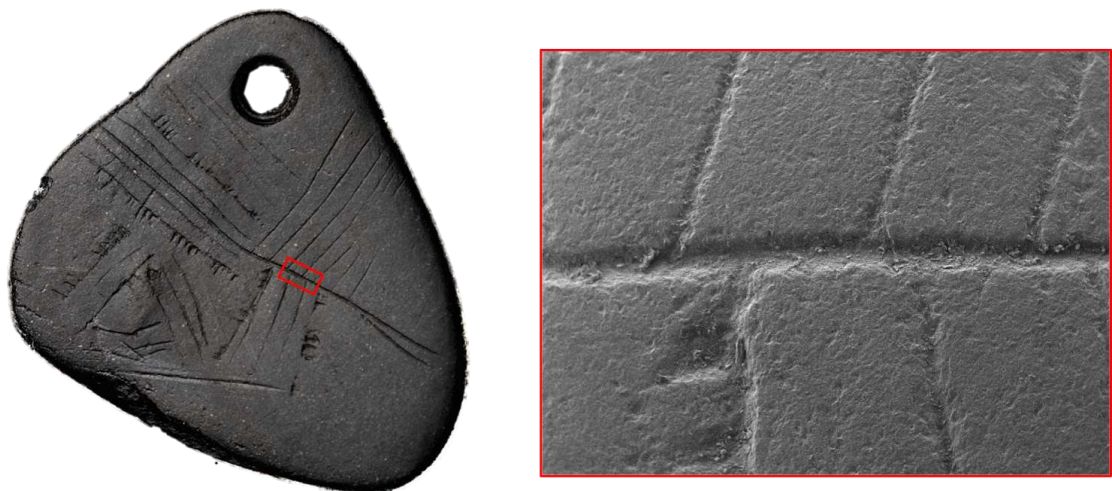


Figure 11: SEM image showing the order of engraving. The central groove is earlier, with the diagonal grooves engraved later. Each groove was drawn from the central groove running away from it. Image captured at 40x magnification using secondary electron mode.

Similarly, the composite images produced using RTI, and manipulating the light source to an oblique position within the software, provided a highly effective tool for assessing the relationships between engraved lines. RTI is a form of computational photography. A set of photographs of an object are captured from a fixed camera and in each photograph the object is lit from a different direction. Using software

called RTI builder these photographs are then combined in order to generate an interactive image within which the user can control the direction and power of the light. RTI Works by calculating the surface of an object based upon the appearance of each pixel when lit from multiple light positions. Each pixel is assigned a direction and an angle of slope based upon its appearance within the original photographic data set. Using the resulting surface model it is possible to apply visualisation algorithms to enhance surface characteristics (Malzbender *et al.* 2004).

RTI has the capacity to reveal complex surface details such as small incisions or wear marks (Riris and Corteletti 2015) and has been used extensively in the detailed examination of archaeological material (Earl *et al.* 2011; Jones *et al.* 2015; Newman 2015), including finds from Star Carr (Duffy 2013). In this instance, the method has helped to enhance the incised surface details on the pendant and the sequence of incisions is made much clearer through the enhancement of specific details at the intersection of lines (Figure 12). RTI has also been useful in helping to develop an overall impression of the patterning through the production of images using specular enhancement (Figure 13). Specular enhancement allows the user to alter the appearance of the captured object by suppressing the colour of the surface and making it more reflective. Using this technique it becomes possible to observe underlying topological characteristics without colour information. This was very useful in observing incisions on the surface of the shale pendant which were unclear from the original photographs.

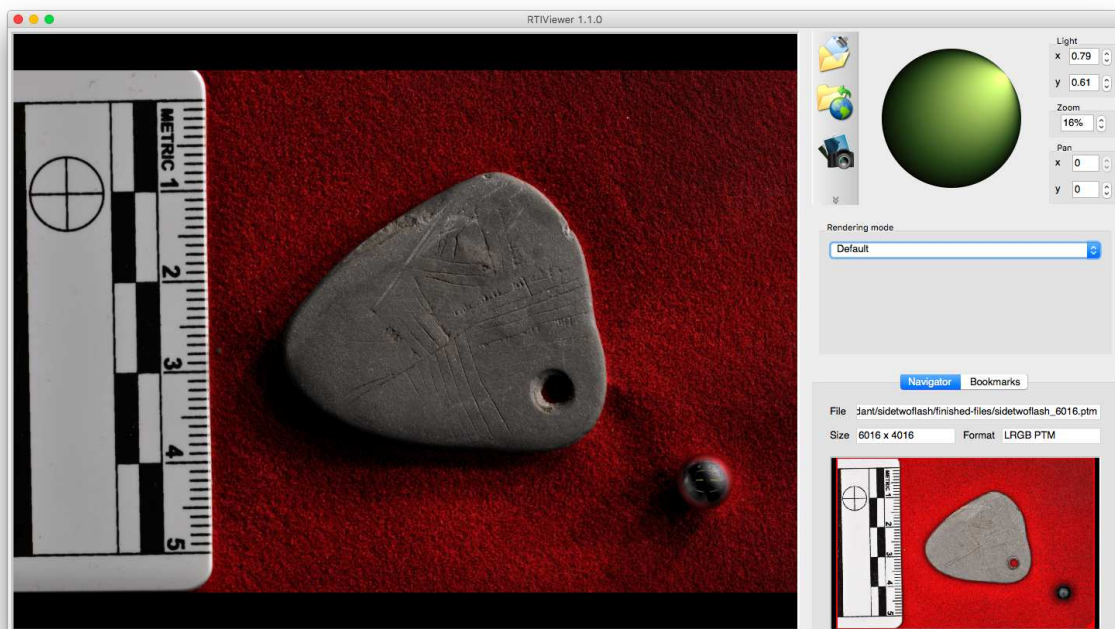


Figure 12: RTI viewer allowing the reader to examine the pendant for themselves. (NOTE THAT THIS WILL BE INTERACTIVE).

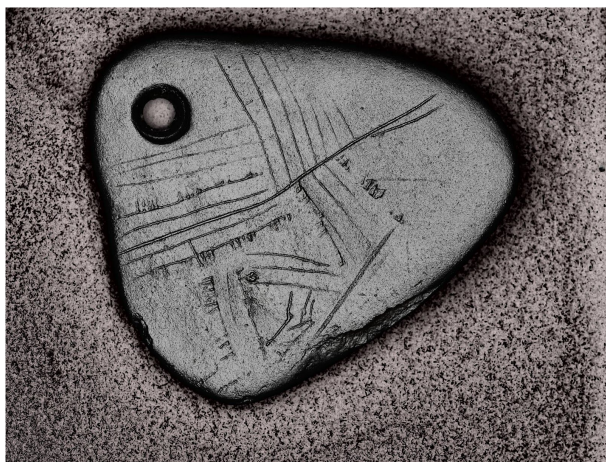


Figure 13: An image of the pendant using specular enhancement.

The light based microscope was used to support a line-order analysis primarily established through these digital methods, being used to cross-check results against the pendant's unmodified surface. The use of these varying methods in tandem yielded a better understanding of what is a very fine and ephemeral series of engraved lines, in parts heavily modified by post-depositional action, than any single method in isolation might have allowed.

In addition, we attempted to surface scan the object in order to create a detailed 3D record, particularly in light of the fact it is very fragile and prone to lamination. White light 3D Surface scanning was carried out using a Breuckmann SmartScan 3D-HE (Breuckmann GmbH., Meersburg, Torenstraße). Both sides were scanned individually and superimposed, using common landmarks found on the edges of both scans, using the image processing software Avizo 8.0 (Visualization Science Group Inc). The mesh was then cleaned using MeshLab v1.3.2 (Visual Computing Lab -ISTI -CNR). This produced a 3D model of the pendant, which while removing the original colour, was able to highlight surface details including some of the faint engraving and the missing nick on the non-engraved side (Figure 5).

4.2. Results

Through the analysis of the pendant using the techniques outlined above, it was possible to gain a sense of the ordering of the lines and the potential phases of the engravings. These are presented in a composite image, Figure 14, and as a slide show with a narrative and rationale.

Phase

- 4c1
- 4c
- 4c2
- 4b
- 5
- 4a
- 3b2
- 3b1
- 3b
- 3a
- 2b
- 2a
- 2
- 1

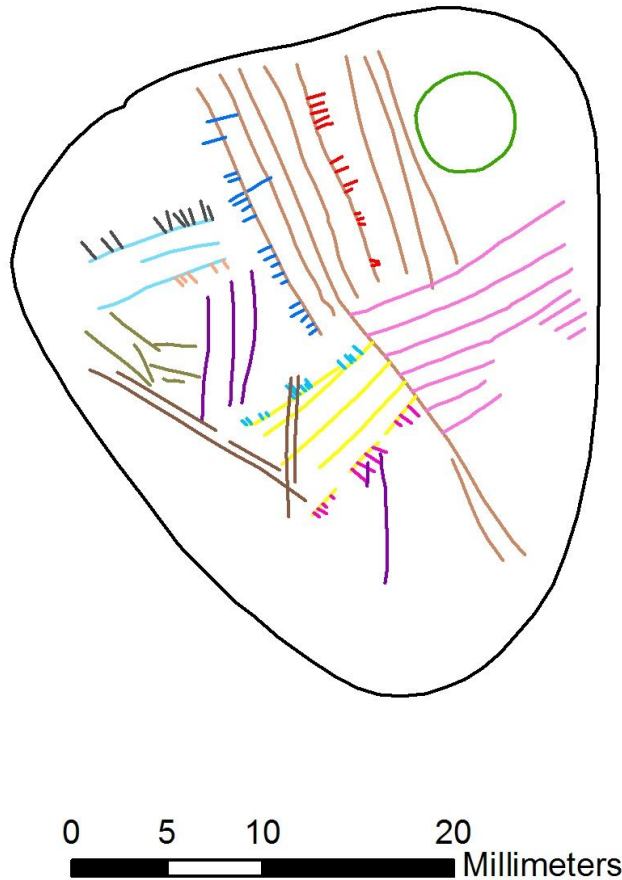
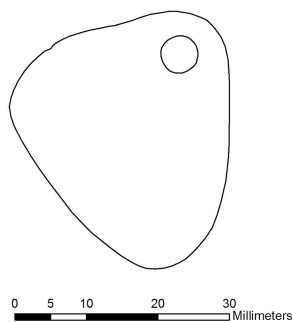


Figure 14: A composite image of phasing, as set out in the slideshow. For ease of orientation in the following discussion, the pendant has been divided into coordinates: north being the top.

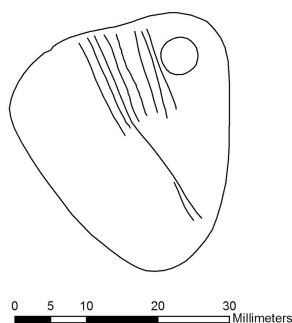
NOTE TO REVIEWERS: This section will be produced as a slideshow and hopefully we can have text one side of the screen and the image the other and the reader can flick back and forth through the images - all slide show images labelled as figure 15

Phase 1: the perforation

The uniconical shape of the perforation suggests working from a single direction, with the engraved surface being the working face. Our experiments have shown that perforating shale poses the risk of breakage, especially when positioned close to the edge as in this case; thus it is probable the piece was perforated and then subsequently engraved. There is no overlap between the perforation and engraving to test this directly. However, the engraving does seem to respect the position of the perforation, and as the drilling action involved in perforating the object could potentially break it there would be a higher risk of damaging the engraving if the object was perforated after it had been engraved.



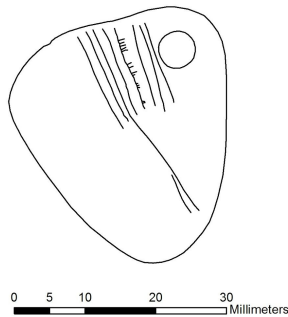
The visible traces of working within the perforation suggests it was produced with a rotational, drilling action. This is likely to have been carried out using a narrow-profile, pointed, retouched tool, such as a microlith or bladelet. Experimental replication confirmed this interpretation, with pieces that were perforated uni-conically, with relatively light pressure, and with the tool prehended rather than hafted, closely resembling the pendant. The neater, smaller hole on the non-engraved side of the pendant (clearly shown in the laser scan, Figure 5) further supports an interpretation of uni-conical working.



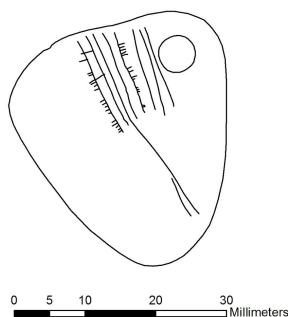
Phase 2: Engravings

There is a series of nine grooves running directly next to the perforation in the direction of the long axis of the pendant, henceforth referred to as phase 2. These grooves have been grouped on the basis of their similarity in profile shape and line orientation, likely indicating the use of the same engraving tool during the same phase of working. As they do not directly interact, the specific order of engraving cannot be ascertained. The working of this series is likely from northwest to southeast. A longer central groove, stretching across the length of the pendant, is of

key significance in phasing the engraving. This groove is deeper and has a shorter groove in association to it on the far south-eastern extent of the pendant.



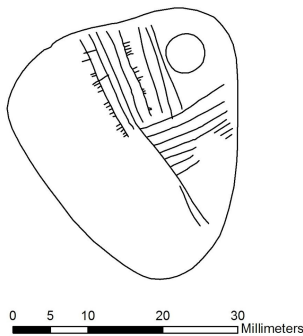
The fourth groove from the perforation in this arrangement has additional grooves drawn from it, 14 in total, henceforth referred to as 2a, and can be described as a barbed line of type C (Clark 1936, 169).



The eighth groove from the perforation to the far west in this arrangement has a number of branching grooves that stem from it, 18 in total, henceforth referred to as 2b, also a barbed line. The nine grooves constituting phase 2 were engraved before phases 2a and 2b. All of the grooves forming 2a and 2b disrupt and cut the grooves of phase 2 where they make contact. It should be noted, 2a and 2b are arbitrary labels and do not reflect the order of phasing. These grooves might conceivably have been added at any later phase, or potentially in smaller groups in multiple phases. As they only cut the grooves of phase 2, and do not interact with grooves from any other phase, it is impossible to discern a specific relationship beyond this, though the most parsimonious hypothesis is that they are temporally associated and together form barbed line motifs. It seems likely, given their uniformity in shape and orientation, that they were engraved at the same time and relatively rapidly after

phase 2, likely using the same engraving tool. The grooves of 2a were engraved from southwest to northeast, while the grooves of 2b were engraved from northeast to southwest. That is, all grooves of these sub-phases were drawn from the point of contact with an existing groove in phase 2, running perpendicular and away from this point of contact.

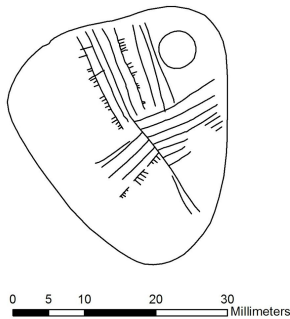
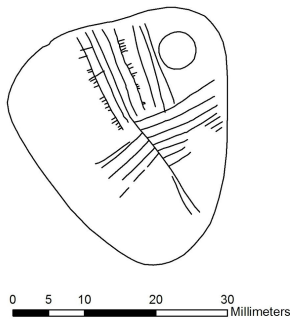
Phase 3: engravings



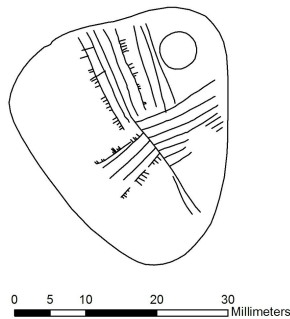
Phase 3 consists of two major groups of grooves, group 3a consisting of seven grooves to the north-east of the central groove and group 3b consisting of five grooves to the south-west of the central groove. Each has been grouped as a sub-phase on the grounds of similarity in profile shape, similarities in the incisions which suggest the same or similar tool was used to produce the grooves, as well as orientation. The grooves composing sub-phase 3a are younger than phase 2, with each groove cutting the profile of the central groove. The direction of working for grooves composing 3a is south-west to north-east. The four grooves to the far south-eastern extent of 3a each have the midsection of the groove partially or entirely obliterated. Initially thought to have resulted from wear, results from use-wear analysis (discussed in section 5) suggests this may have been caused by post-depositional factors (PDSM). The groove to the far north-western extent is significant in that it disrupts the terminus of the northern grooves in phase 2, confirming that sub-phase 3a, and by extension perhaps all of phase 3, is younger than phase 2.

Paralleling sub-phase 3a, sub-phase 3b consists of five grooves, each disrupting and cutting the central groove at the point of contact, indicating they are each younger than phase 2. The direction of working for grooves constituting 3b is north-east to south-west. As identified in previous phases, grooves constituting 3a and 3b are engraved from a point of contact with an earlier groove and are engraved in a perpendicular orientation, running away from the point of contact. Grooves to the

southern extent of 3b at the groove mid-point and further west have again been partly obliterated, as was noted for grooves to the south-eastern extent of 3a.



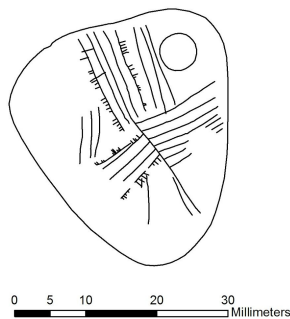
Paralleling the pattern identified in phase 2, barbed line groupings of small, perpendicular lines stemming from longer grooves appear. Sub-phase 3b has two further such groupings, sub-phase 3b1, composed of 11 short grooves contacting the far southern groove of sub-phase 3b, and sub-phase 3b2, composed of 14 short grooves contacting the far northern groove of sub-phase 3b. These have been grouped into sub-phases on the grounds of similarity in profile shape, suggesting the same tool might have been used, as detailed above for other phases.



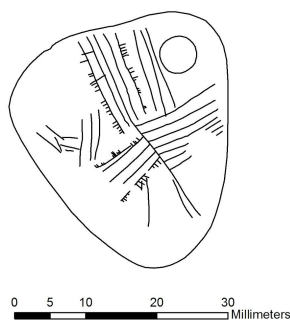
Sub-phases 3b1 and 3b2 conform to the pattern described more broadly, with each groove cutting through the profile of grooves belonging to sub-phase 3b, indicating that all short grooves belonging to sub-phases 3b1 and 3b2 are younger than grooves belonging to sub-phase 3b. Short grooves associated with sub-phase 3b1 have been engraved from northwest to southeast, while short grooves forming sub-phase 3b2 have been engraved from southeast to northwest. This pattern again conforms to that seen for earlier phases where the direction of working runs away from contact at a perpendicular angle to the earlier groove.

Phase 4: engravings

The groupings of phase 4 are more contentious, in part due to a lack of direct contact between phases previously described and an arrangement of grooves that do not conform to the same pattern, with fewer interconnections between grooves. Three sub-phases and two additional sub-phases linked to one of these sub-phases are evident, but the phasing of the piece here becomes ambiguous. It could be that phase 4 follows phase 3, occupying one of the few vacant areas left on the surface, or it could be the exact opposite, actually representing the earliest phase, with those phases already described engraved at a later time. These possibilities are explored in greater detail in the phasing summary below.



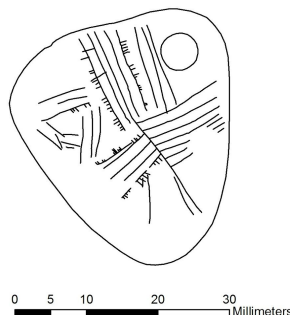
Sub-phase 4a consists of three grooves engraved from north to south. These grooves have been grouped based on direction of working, orientation and the similarity in profile shape. The far western groove in this sub-phase looks to be cut by grooves associated with sub-phase 4b, described in greater detail below, suggesting 4a may be an older component of phase 4. Significantly, an otherwise anomalous set of two possible grooves may be associated with phase 4a, based on their orientation. However, the spatial dislocation of these grooves, as well as the dissimilarity in profile size and shape makes such an association highly tentative. If they are associated, this would be highly significant as it would potentially offer a way to directly link and order phases 3 and 4. However, the relationship between these grooves and sub-phase 3b1 could not be discerned.



Sub-phase 4b is more complex and dissimilar to most other groupings in that it is formed of grooves seemingly worked in two differing orientations. It is composed of six grooves, broadly set out in two groups of three. These grooves have been grouped largely on the grounds of their close spatial relationship and their dissimilarity to the otherwise structured patterning evident in other phases. Those grooves from the eastern component of the grouping have tentatively been worked

from east to west and disrupt the far western groove from sub-phase 4a, as discussed above. This would suggest sub-phase 4b is younger than sub-phase 4a. The grooves forming the western component of sub-phase 4b can be tentatively interpreted as having been engraved from northwest to southeast. The specific interaction of these grooves at contact is ambiguous, though it can be noted that an anomalous north/south orientated groove interacts with grooves from both sub-groups.

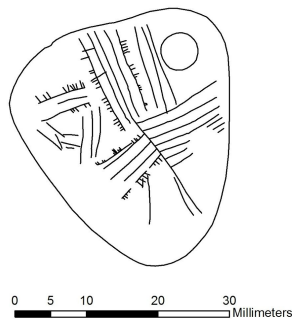
Sub-phase 4c consists of 3 grooves that have been grouped on the basis of orientation, profile shape and direction of working. They do not interact with any other groupings and so are challenging to interpret. However, sub-phase 4c is associated with two further sub-phases, 4c1 and 4c2, which when taken together bears a striking resemblance to barbed line groupings described in phases 2 and 3 above. The grooves forming 4c have been engraved from east to west.



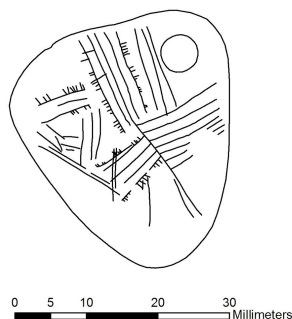
Sub-phase 4c1 is associated with the far southern groove of sub-phase 4c, and consists of five short grooves. They have been grouped based on their profile shape, orientation and direction of working. These follow the familiar pattern described above of having been worked at a perpendicular angle, each cutting the groove of 4c with which they interact, demonstrating they are younger. These grooves have been worked from north to south. Sub-phase 4c1 is younger than sub-phase 4c.

Sub-phase 4c2 is associated with the far northern groove of sub-phase 4c. It is composed of 10 short grooves that have been phased together based on their profile shape, orientation and direction of working. The grooves have been engraved from south to north in all cases. Sub-phase 4c2 parallels sub-phase 4c1 in that the grooves have been worked at a perpendicular angle to the groove with which they interact from sub-phase 4c, running away from the point of contact. In each case, the grooves of 4c2 disrupt the groove from 4c, demonstrating that the grooves belonging to sub-phase 4c2 are younger than sub-phase 4c. The close similarity between this pattern of sub-phases when compared to similar groupings described in phases 2 and 3 may suggest a relationship; the pendant may have been engraved in a single event, the phases perhaps reflecting momentary pauses and adjustments as the

object was repositioned rather than longer temporal dislocations between phases of working.



Phase 5: modern damage



Phase 5 is composed exclusively of modern excavation damage caused by contact with a trowel, with at least two strikes causing some marking and with some possible evidence for a scraping motion.

4.3. Summary of phasing

Analysis of line-order reveals two major phases of lines, as expressed in Figure 16. The majority of lines conform to a pattern of intersecting earlier phases of engraving at a perpendicular angle. Some of these arrangements conform to Clark's (1936, 169) barbed line type C designs. A repeating element emerges in this arrangement, with longer lines later intersected by smaller lines. This is most evident with the

smaller, tightly packed groups of lines, expressed as sub-phases above. These barbed line groups always feature to the outermost lines of a series of longer lines and repeat across multiple orientations. This very specific pattern suggests they might have been produced contemporaneously. On the grounds of orientation, an additional phase emerges, which does not entirely conform to this pattern. Lines are grouped, parallel and of a similar length, though markedly less so, with a significant spatial dislocation in those lines running north/south.

The chronology of these differing working styles is difficult to discern. There is no unambiguous point of connection between phases 3 and 4. It could be the case that the more erratic pattern is the earliest engraving. The later engraving of the more heavily ordered phases might have cut over the top of a pre-existing design, of which this is the remnant. This model necessitates heavy wear to the surface, obliterating much of the earlier design through a combination of wear and re-engraving. Given the soft raw material, this is a feasible interpretation. However, the more parsimonious model would instead place the erratic engraving as a later phase that filled areas of empty space. It is interesting to note that those lines which feature small, grouped lines are never subsequently cut by longer lines. If this observation holds true, there was no further room for any long linear lines running west/east / east/west to the southern half of the pendant given the placement of the existing arrangements running north/south. Instead, the orientation has been changed and further long linears used to fill the gaps. In this model these 'erratic' lines do fit the broader pattern of working but reflect the increasing lack of space and difficulty in properly repeating the pattern of working. This must remain a speculative hypothesis given the lack of direct discernible relationship between phases 3 and 4.

The presence of a repeating barbed line pattern (Clark 1936) across multiple phases of the engraving is significant in potentially supporting a model of the rapidly laying down of lines across the surface of the pendant. It would be less parsimonious to view a very specific design pattern feature over multiple phases of working over long time scales but which maintained a rigid sameness to earlier phases. If later phases emulated earlier phases, one might still see some variance through, for example, inaccurate copying.

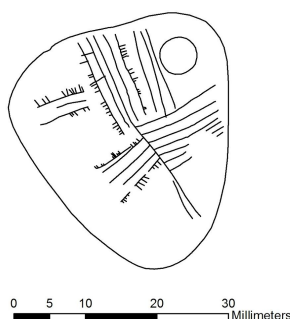
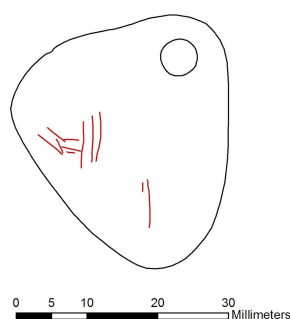


Figure 16: The two main types of lines.

5. Use-wear and residue analysis

5.1. Use-wear analysis

Recent microwear research carried out on Mesolithic ornaments, mostly from burial contexts, has shown that this method can reveal significant information regarding an ornament's manufacture and function (Cristiani *et al.* 2014a; Cristiani *et al.* 2014b; Larsson 2006; Rigaud *et al.* 2015). With this in mind microwear analysis was carried out on the pendant. Using a low power stereoscope at magnifications x10-x100, followed by high power analysis with a Leica DM1750M reflected light microscope at magnifications ranging from x10-x50, with eyepiece magnifications at x16, the entire surface of the pendant was analysed for wear traces.

Analysis was made difficult by the amount of highly reflective inclusions of what appeared to be iron pyrite (see residue section) and post-depositional surface

modification (PDSM) which has resulted in the entire surface displaying a sheen or 'brightness'. This brightness is caused by two factors: reflective pyrite inclusions and a general abrasion to the surface caused by the pendant, being made of soft shale, sitting in mud and water for 11,000 years.

The slightly more worn areas of the engraving mentioned in section 4.2 phase 3 (Figure 17) display no wear polish that can be attributed to anthropogenic activity; microscopically, there is no distinction on the surface of the pendant at these locations from other parts of the surface. One explanation is that they may, due to their higher topography, have become more affected and worn through time due to natural processes.

No discernable evidence for wear traces relating to suspension could be found from within or around the perforation. However, it remains possible that the pendant was suspended and worn, but for such a limited duration of time as to not leave any traces. Indeed, it is also possible that it was intended for a single use, such as a ceremony, which is unlikely to leave any signatures of use at all. The adjacent edge of the nearest vertex did, however, display a slightly brighter sheen compared to the other edges. This is also the location where polish emanating from wear would be expected if the pendant was suspended with the perforation at the top and the long axis of the triangle at the bottom. This may indicate that it was in fact suspended and worn as a pendant but as this location is just a slightly brighter area and cannot be characterised as polish *per se* (Vaughan 1985), and displays no clear directionality, striations or rounding, and given that the entire surface of the pendant has a sheen, such an interpretation comes with a strong caveat.

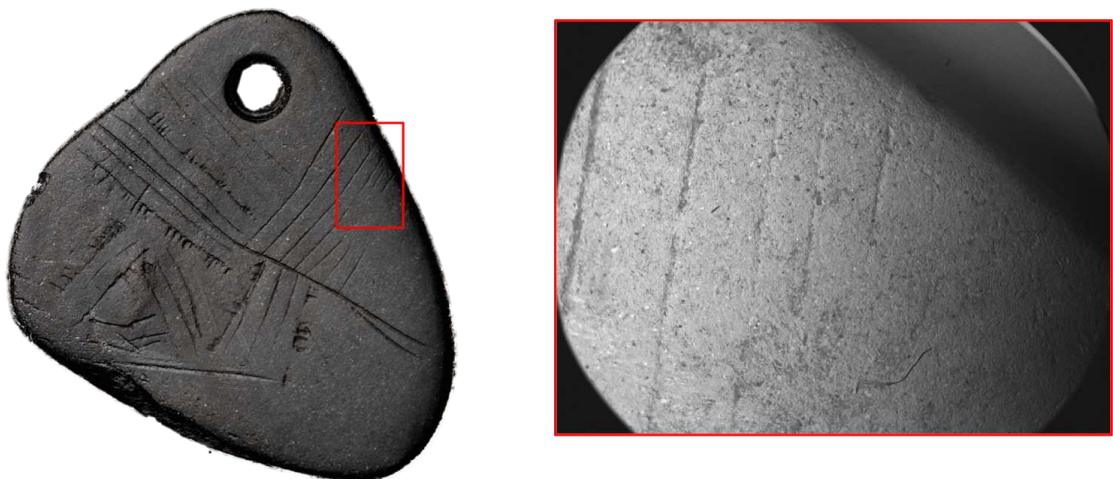


Figure 17: SEM showing areas of engraving that have been obliterated, probably from natural processes. Captured at 25 x magnification using secondary electron mode.

5.2. Residue analysis

5.2.1. Aims

The pendant was investigated for any microscopic trace residues which might indicate how it had been made and used, with a particular focus on whether coloured materials, such as ochre, charcoal, or resin had been used to emphasise the lines. Four residues were identified: brown staining, gold-coloured crystals, biological structures, and white crystals. In addition, two soil samples from the same context as the pendant were tested as controls for contamination from the surrounding burial environment.

5.2.2. Methods

The pendant was first analysed using reflected light microscopy (Leica DM1750 M), using objectives ranging from 5 x to 100 x, and an eyepiece magnification of 16 x. Each engraved line on the pendant was systematically examined and the locations of microscopic residues were mapped. A series of z-stacked micrographs were taken for each microscopic residue to make a composite image, using Leica Montage software. Soil sample controls were prepared by direct mounting on glass slides with double sided tape and examined with reflected light microscopy. Secondly, located residues were investigated with a variable pressure SEM (Hitachi TM3030Plus), as outlined in Section 4.1.

Residues were further analysed with microscopic confocal Raman spectroscopy (Micro-Raman). Micro-Raman is a spectroscopic technique utilised for the identification of crystal and molecular structures employing lasers to excite vibrational and stretching modes within the samples; this technique can suggest the chemical nature of microscopic residues with a high degree of specificity. Micro-Raman is minimally destructive to the residue in that an area of the residue of interest, about 20 μm^2 , is burned by the incident laser beam during analysis. A HORIBA Jobin Yvon Xplora confocal Raman microscope with LabSpec 6 and IGOR Pro software for peak analysis were used to collect and evaluate spectra (Physics Department, University of York).

Four areas of the pendant were investigated with Micro-Raman: brown deposits within the engraved lines, gold-coloured structures (suspected to be pyrite), biological structures, and white crystals within the perforation hole. The 100x objective was used to record images of the exact locations of laser penetration on each residue. Many spectra of suspected pyrite crystals on the pendant were collected, however, fluorescence of the material and scattering due to the microtopography of the sample often resulted in spectra which had poor signal to

noise ratios. Thus, several spectra were discarded because they were too 'noisy' to discern any peaks.

5.2.3. Results: brown stains

The depressed area within the engraved lines contained brown deposits (Figure 18). Micro-Raman analysis was conducted to identify the possible presence of crystalline phases in these areas that could be associated with the presence of pigments. However, the respective spectra showed no evidence for this. Rather, spectra collected from the brown deposit within the lines shows that the brown material is organic in nature (Figure 19) and it is very likely that this is peat from the burial environment which has become entrapped within the grooves.

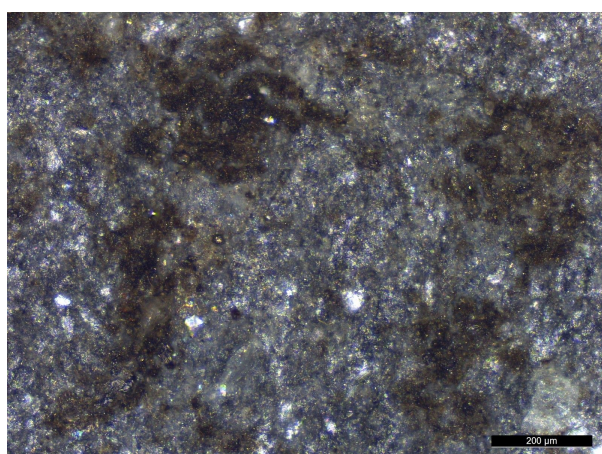


Figure 18. The engraved lines on the pendant can be seen microscopically as depressed grooves with brown infilling. LM.

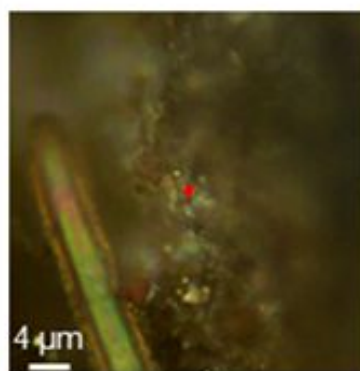
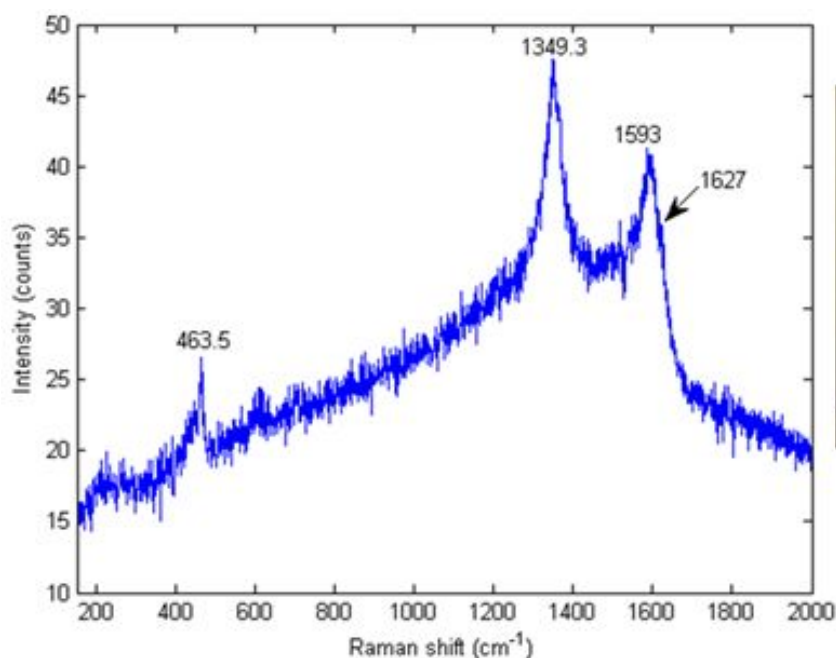


Figure 19. Micro-Raman spectra taken of brown deposit from within engraved line 11. Clear presence of organic material is indicated, likely peat.

5.2.4. Results: gold structures

A large number of gold structures were seen on the pendant during inspection with light microscopy. These structures were located on the surface of the stone, in the engraved lines, in the perforated hole, and also within a nick on the back of the pendant. Two types of gold structures were found: equilateral triangles (max diameter approximately 5.6 μm), and granular spherical crystals (max diameter approximately 40 μm) which were located on the non-engraved side of the pendant within the nick mark (Figures 20 and 21).

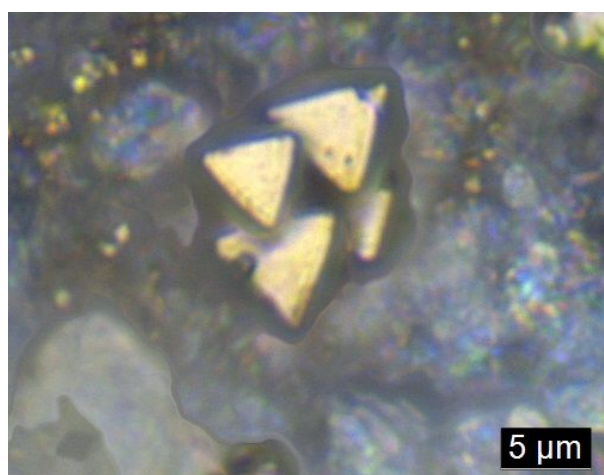


Figure 20: Gold structures with triangular faces. LM.

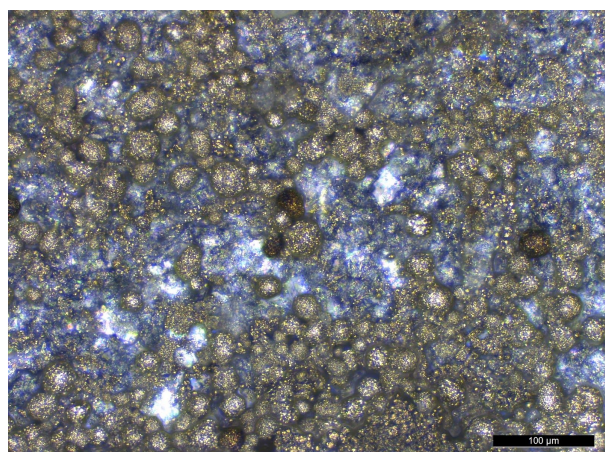


Figure 21: High density of granular spherical crystals located within the nick mark on the non-engraved side of the pendant. LM.

It was noted that pyrite had previously been found at Star Carr, possibly used as firelighters (Clark 1954, 20) though none have been found within the museum archives (Milner *et al.* 2013a) for comparison. One hypothesis on discovering the pyrite on the shale pendant was that it might have been struck with iron pyrite. A reference piece from the nearby coast was pounded on a hard surface and the

resulting residue mounted on a slide for observation. It was clearly shown that this produced angular pieces as opposed to the forms found on the pendant (Figure 22).

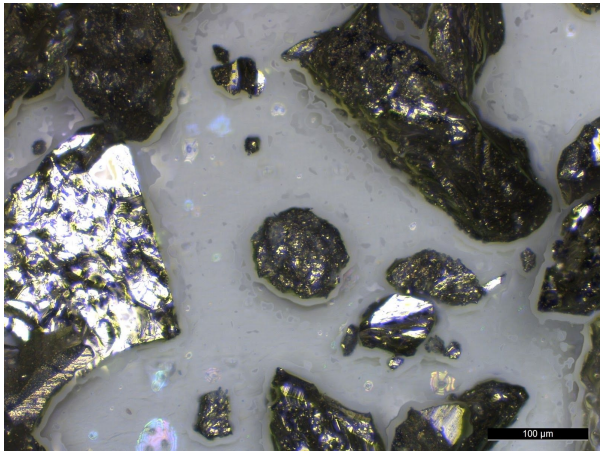


Figure 22: Gold angular pyrite from the reference collection. LM.

The framboidal structures seen under the light microscope were confirmed under SEM as overall spheroid shapes with individual cubo-octahedral microcrystals (Figure 23) (cf. Butler and Rickard 2000; Popa *et al.* 2004), typical of pyrite. The Raman data obtained support the suggestion that the crystal structures with triangular faces and the framboids were pyrite. Figure 24 shows an example of the spectra obtained from these samples.

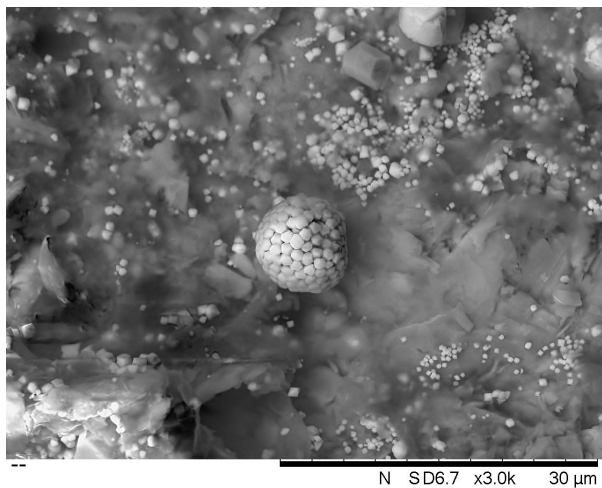


Figure 23: Close up of a pyrite framboid with cubo-octahedral microcrystals. SEM, backscattered electron mode.

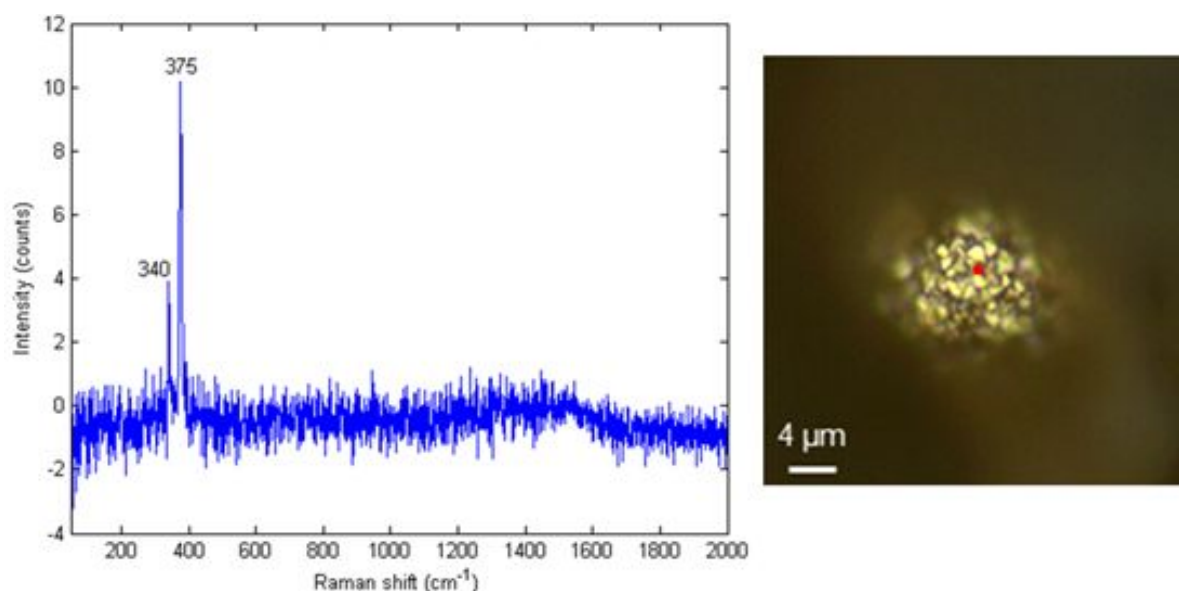


Figure 24: Micro-Raman spectrum collected from the red spot on the framboidal structure.

Anisotropic pyrite contains two intense peaks at $\sim 342\text{ cm}^{-1}$ and 377 cm^{-1} , and one minor peak at 428 cm^{-1} (Mernagh and Trudu 1993, 118). The ENS de Lyon Handbook of Minerals Raman Spectra (Anon 2000) quotes three Raman frequencies in anisotropic pyrite: two strong peaks at 340-342 and 375-377, as well as a minor peak at 428 cm^{-1} (Handbook of mineral spectra, ENS de Lyon). According to Demoisson *et al.* (2008, 345), pure pyrite shows scattering signals at 340 and 377 cm^{-1} . Both Raman spectra from the triangular crystals and framboids are consistent with reference spectra for anisotropic pyrite. As can be seen in the spectrum figure X, the first two prominent bands are clearly present. The third low-intensity peak at 428 cm^{-1} noted by Mernagh and Trudu (1993) and ENS de Lyon (Anon 2000) is not completely clear. The third peak may be present, but it is difficult to resolve due to signal to noise distortion in the spectrum.

It is concluded that the gold-coloured crystals found on the pendant are natural pyrite, not an anthropogenic addition of pigment to the pendant. Pyrite is known to form naturally by the decomposition of organic material in peat bogs (López-Buendía *et al.* 2007). Triangular and framboid pyrite crystal formations were also observed within two soil samples taken from the context in which the pendant was found.

5.2.5. Results: biological structures

Several unidentified fragments of what appear to be lacustrine zooplanktonic microfauna such as fairy shrimp, copepods, cladocerans, ostracods, or insects, were identified within the engraved lines of the pendant. One of these fragments, mapped to location 1 within line 1 on the pendant surface (Figures 25 and 26) is probably the remains of a copepod, a very small crustacean. No microfauna were found within the

soil samples analysed, although specimens may have been bound up in soil aggregates and thus obscured.

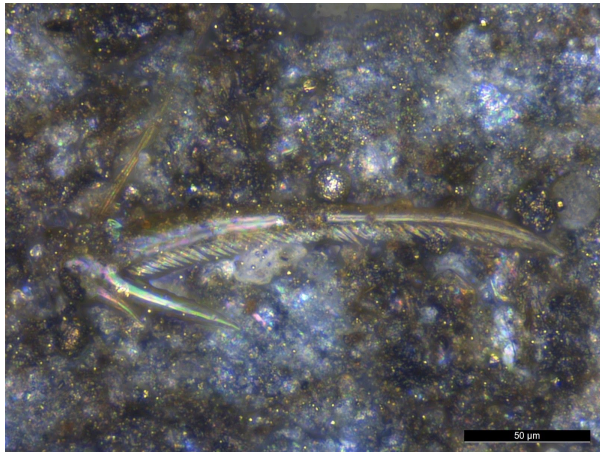


Figure 25: Fragmentary microfaunal remains, likely part of a copepod. Location 1, Line 1. LM.

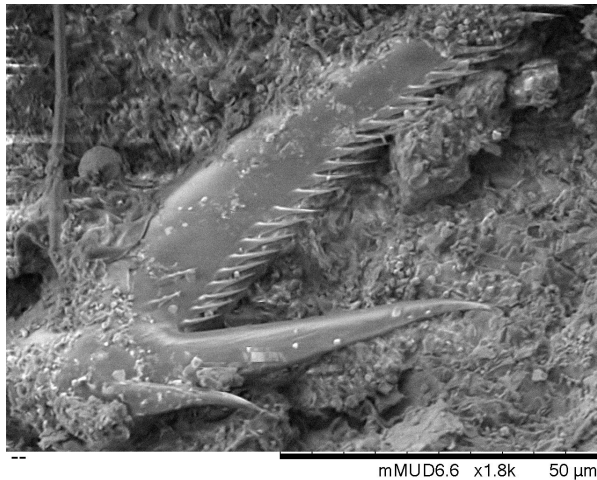


Figure 26: Fragmentary microfaunal remains, likely part of a copepod. Location 1, Line 1. SEM, secondary electron mode.

There was some question as to whether the putative biological structures were perhaps mineral in origin. Thus, one of these structures (at location 9 on the pendant, see Figure 27) was investigated with Micro-Raman in three locations. The presence of carbon in three spectra confirmed it was organic (Figure 28).

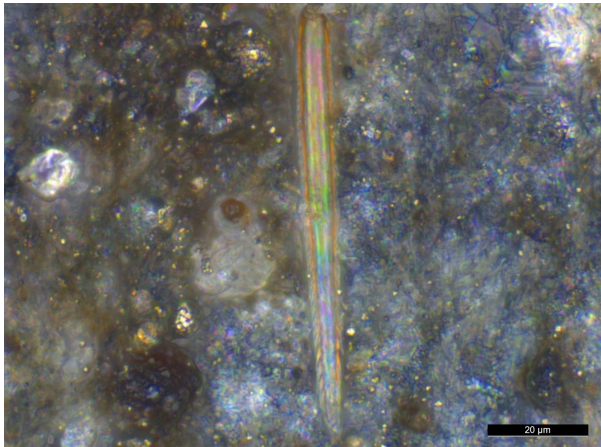


Figure 27: Loc 9. Biological structure, possibly a diatom. Micro-Raman analysis has showed the structure is carbon-rich, and thus likely organic. Loc 9, Line 11. LM.

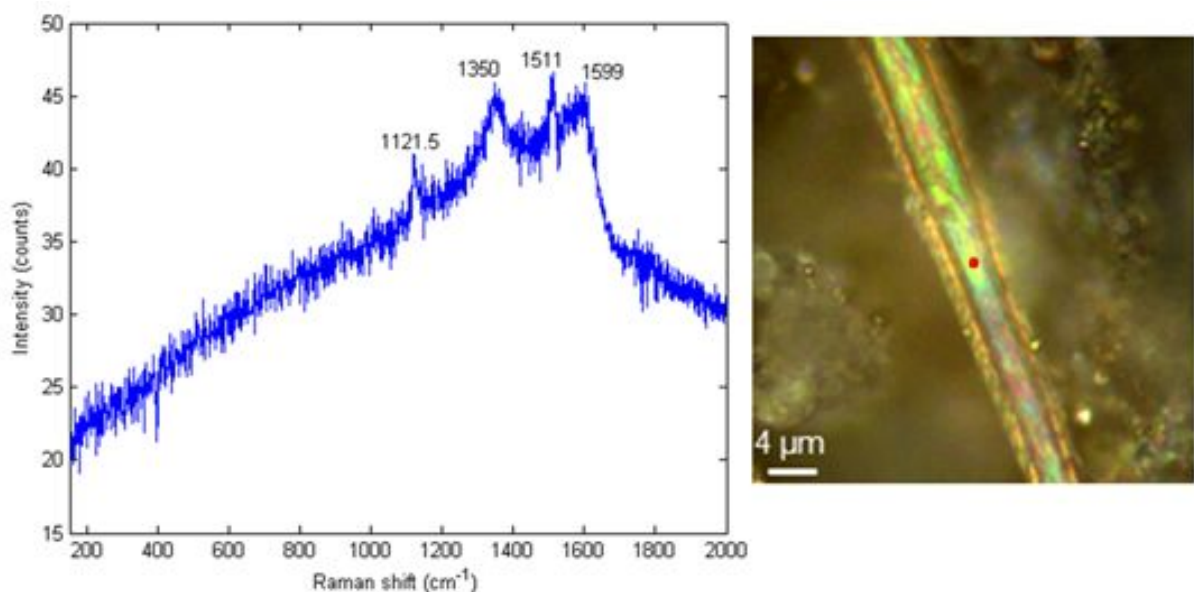


Figure 28: Raman spectrum collected on suspected microfaunal remain in one of three locations demonstrating that this is organic.

The conclusion from the Micro-Raman analysis is that these are biological structures but a number of specialists have been unable to identify what they are specifically. They are not related to the use or manufacture of the artefact and might have adhered within the engravings due to the pendant being placed within the lake edge deposits where such microfauna naturally occur.

5.2.6. Results: white crystals within the perforation

Clear and white translucent globular crystals were located within the perforation of the pendant. These crystals were not angular, but show what appears to be weathering as their edges are rounded (Figures 29 and 30).

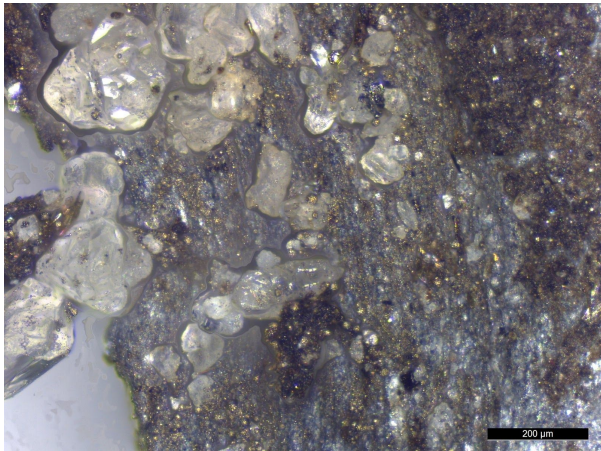


Figure 29: Rounded quartz crystals within the perforation of the pendant. LM.



Figure 30: SEM image of the perforation and crystals within it. Image captured at 200 x magnification.

These crystals were investigated with Micro-Raman. Good quality spectra with minimal noise and fluorescence were able to be obtained on the smooth surface of one of these crystals (Figure 31). According to Kingma and Hemley (1994, 270), the most prominent Raman band in quartz (SiO_2) is located at 465 cm^{-1} , which is detected in our spectrum at around 464 cm^{-1} . The ENS de Lyon Handbook of Mineral Raman Spectra (Anon 2000), quotes 464 cm^{-1} as the most intense frequency of powdered quartz, matching the major peak we obtained. Less intense bands related to the Raman assignment of quartz were also detected in our spectrum as indicated.

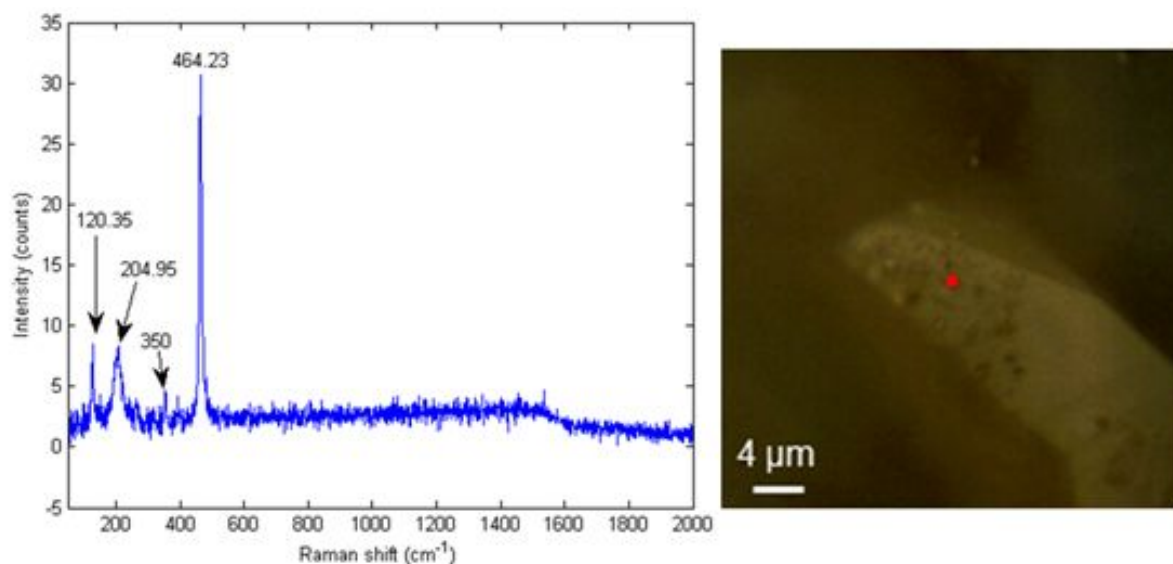


Figure 31: Micro-Raman spectrum collected from a crystal grain located within the perforation of the pendant.

In conclusion, the Raman spectrum matches closely with reference spectra for quartz. Clear crystals which were hexagonal in two dimensional outline were also noted in one of the soil samples, although no suggestion can be made as to their chemical nature. No quartz crystals similar in appearance to those found within the hole of the pendant were able to be located in the soil samples. However, it should be noted that only two soil samples from the context were analysed. Also, no soil samples that were in direct contact with the pendant were taken at the time of excavation, and thus it is possible that this surrounding area may have contained the same quartz sand as found within the hole.

The reason for the quartz in the perforation is not clear. One possibility is that the sand had been used in the manufacture of the hole; however, experiments over the last year on shale have shown that because shale is a soft stone it is very easy to create a hole with a flint tool, such as a with a stone drill (*mèche de forêt*) and that sand would not be necessary.

The origin of this sand remains an enigma: quartz crystals were not found anywhere else on the pendant and not within the soil samples analysed. However, sand is present on the site, and in some cases within areas of the peat because it has washed down from the dry land. Therefore, it may be that fine sand has settled within the hole as part of the deposition process, perhaps even because the lake water has filtered through this hole.

6. The pendant in context

6.1. Overview of engraved portable art in southern Scandinavia

Overall, engravings on Mesolithic pendants are extremely rare, with the exception of amber pendants found in southern Scandinavia (Płonka 2003). Art has also been found on a number of other types of portable artefacts made from a range of materials including bone, flint, antler and wood, and the centre for this art can be argued to be Denmark due to the sheer quantity of examples that have been found there; other pieces have also been found in Sweden, Germany, Poland, Russia, Estonia, France, Belgium, Spain and Britain (Płonka 2003). It is unclear exactly how many pieces exist, but Nash (1998, 2) suggested that at least 400 antler and bone artefacts with art inscribed on them originate from Denmark.

An example of an elaborately decorated piece of antler derives from Bodal Mose, in the Åmose on the island of Zealand, Denmark, which was found as a stray find in 1950 (Andersen 2001; Brinch Petersen 1982). Its surface had been smoothed and was decorated with geometric motifs of an animal and the outline of what has been interpreted as a human being (Figure 32), a sleeping shaman or a shaman in a trance, possibly used in connection with a hunting ritual. The human and animal are covered by parallel incised lines, which may represent skins (Andersen 2001).

In terms of pendants, a total of 73 decorated amber pendants have been found in Denmark, Skania in Sweden and Holstein in northern Germany (Toft and Brinch Petersen forthcoming) (see Figures 33 and 34 for examples). Of these, the majority are stray finds (e.g. Fischer and Vang Petersen forthcoming; Nielsen 1982) and only seven are derived from in situ contexts: five from Zealand and one each from Jutland and northern Germany (Andersen 1998; Andersen *et al.* 1982; Fischer and Vang Petersen forthcoming; Hartz 1998; Henriksen 1980; Toft and Brinch Petersen forthcoming; Vang Petersen forthcoming). Although these pendants have been made from amber, antler and bone have also been used (Andersen 2001; Gramsch 2014). The pendants are perforated and often polished, which may have resulted from preparation before decoration, handling and use in antiquity (Andersen 2001) or water rolling (Vang Petersen forthcoming). Some also have faint grooves present (Andersen 2001; Vang Petersen forthcoming) which researchers have argued indicates that these objects were attached to a cord and worn around the neck as pendants or amulets (e.g. Clark 1936; Gramsch 2014; Toft and Brinch Petersen forthcoming; Vang Petersen forthcoming), although this conjecture is far from certain.



Figure 32: The antler piece from Bodal Mose, Åmose (Photograph by Arnold Mikkelsen, Nationalmuseet, <http://samlinger.natmus.dk/DO/9617>).

A range of markings were produced using three techniques: boring, carving and incision (Clark 1936). These techniques have been observed on objects from sites dated throughout the Mesolithic in Denmark: from the Maglemose (Early Mesolithic), the Kongemose (Middle Mesolithic) and Ertebølle (Late Mesolithic). Markings include variations on lines and barbed lines, chevrons, net patterns, chequer patterns, lozenges, variations of cross-hatched lines, and hachured triangles (Clark 1936; Nash 1998).



Figure 33: A selection of amber pendants from Denmark. Some objects exhibit engraved lines similar to the pendant found at Star Carr. Others demonstrate the drilling technique to produce lines of dots (Photograph by Arnold Mikkelsen, Nationalmuseet <http://samlinger.natmus.dk/DO/9628>).



Figure 34: A close up of some of the amber pendants from Denmark which exhibit the engraving method and the barbed line technique. Perforations at the top, presumably made in order to hang the pendant, have broken. Note also that the pendant on the left has two perforations, which is similar to the pendant found at Star Carr (Photograph by Arnold Mikkelsen, Nationalmuseet, <http://samlinger.natmus.dk/DO/9661>).

6.2. Overview of art in Britain

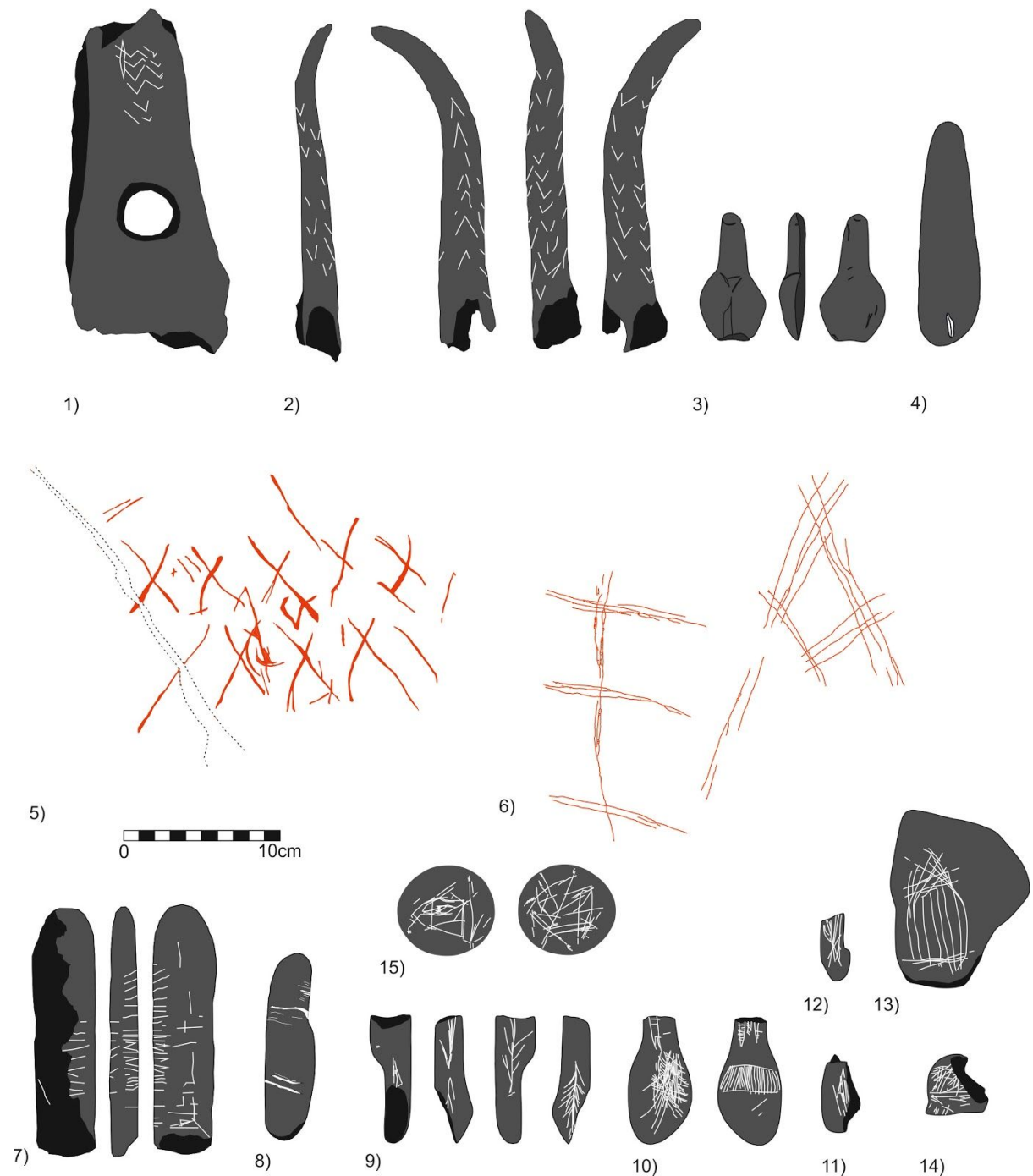


Figure 35: (1) Decorated bone adze, Hammersmith; (2) Decorated antler tine, Romsey; (3) Stone Phallus, Nab Head; (4) Stylised Venus, Nab Head; (5) Incised motif on cave wall, Aveline's Hole (6) Incised motif on cave wall, Long Hole; (7) Incised pebble, Trevoise Head; (8) Incised pebble, Camas Daraich; (9) Incised pebble SF1, Rhuddlan; (10) Incised pebble SF2, Rhuddlan; (11) Incised pebble SF5, Rhuddlan; (12) Incised pebble SF4, Rhuddlan; (13) Incised pebble SF6, Rhuddlan; (14) Incised pebble SF3, Rhuddlan; (15) Incised pebble B127, Llandegai

Although far from ubiquitous, decorative artwork is (sparsely) distributed throughout the archaeological record of the British Mesolithic, both spatially and temporally.

Geometric patterns incised into material culture can be found on artefacts across the British Isles from Camas Daraich, Skye (Clarke *et al.* 2012), to Rhuddlan, Denbighshire (Quinnell *et al.* 1994), Trevoise Head, Cornwall (Smith and Harris 1982) and Hammersmith, London (Smith 1934) (Figure 35). In addition to this, sculpture ‘in the round’ has been demonstrated through a stylised shale phallus from Nab Head, Pembrokeshire (David and Walker 2004), whilst an Early Mesolithic date has been suggested for two instances of incised cave art at Aveline’s Hole and Long Hole, Somerset (Mullan and Wilson 2007).

Chronologically, dating evidence suggests that art is distributed throughout the Mesolithic. Accelerator Mass Spectrometry (AMS) C14 determinations place artistic activities in the 9th, 8th and 7th millennia cal. BC (see Table 1). However, at present, only the Llandegai pebble can potentially be linked to the 6th and 5th millennia cal. BC, unlike in northern Europe where art exists during Late Mesolithic, Ertebølle contexts (Andersen 1981, 2001).

Site	Type	Date	Calibrated	Dating notes
Hammersmith, London	Incised bone tool	OXA-17128 8505 +/-45BP	7596-7508 cal. BC	Direct AMS date on decorated artefact
Romsey, Hampshire	Incised antler	OxA-17161, 8517±40 BP	7595-7522 cal. BC	Direct AMS date on decorated artefact
Aveline’s Hole, Somerset	Incised cave art	Multiple	8460-8140 cal. BC	Modelled date for the cessation of activity and sealing of the cave - potential to be earlier
Long Hole, Somerset	Incised cave art	?Early Mesolithic	No associated dates	Early Mesolithic material within the cave
Nab Head I, Pembrokeshire	Shale beads and sculpture	OxA-1495 9210±80 BP OxA-1496 9110±80 BP	8623-8283 cal. BC 8567-8021 cal. BC	
Rhuddlan M, Denbighshire	Incised pebble	BM-822 8528±73	7728-7426 cal. BC	Date on bulked hazelnut fragments from within feature M90 containing one of the pebbles. Associated

				microliths suggest this may be too young.
Trevose Head, Cornwall	Incised pebble	Mixed Meso/Neo context	No associated dates	
Camas Daraich, Skye	Incised tool	7545± 55BP 7574±75BP	6481-6251 and 6591-6254 cal. BC	Dates cited in Clarke <i>et al.</i> (2012, 3)
Llandegai, Bangor	Incised pebble		4100-3900 cal. BC	Inferred from association with rod microlith and Early Neolithic pottery (Griffiths 2014; Lynch and Musson 2001)

Table 1: dates of Mesolithic art found in the British Isles. Raw dates from original publications calibrated using Oxcal 4.2 and r% IntCal 13.

Whilst several authors note the presence of these expressive practices within Mesolithic Britain, few have offered interpretations for the meaning behind these actions. By far the most debated piece of material culture in relation to British Mesolithic art is the Nab Head shale ‘amulet’. The original excavator rather prudishly described this as a ‘duck-head’ (although later conceded that it may in fact be a ‘venus phallica’ (Gordon-Williams 1926). Abbé Breuil took an interest in the object noting the similarities to both a phallus and the the hips and waist of a woman. This led Breuil to interpret it as a coded *jeu de mots*, blending references to gender and fertility (Breuil 1955). Jacobi (Jacobi 1980) identifies a further piece of shale within the Nab Head assemblage which shows signs of working, and he links this to more stylised representations of the female form. The context of deposition of the Nab Head ‘phallus’ has also been noted, apparently having been placed into the ground alongside nine shale beads (Chatterton 2003).

Clark (Clark 1936) linked the chevrons observed on the Romsey decorated antler and Hammersmith bone adze to similar artistic patterns from across Europe. He states that they were created through incision with a fine and sharp tool, and that these methods of decoration are exemplified by the assemblages of Sværdborg and Holmegård in Denmark (Clark 1936, 162). These form part of a wider group of bone and antler artefacts featuring ‘single chevrons often one placed above another’ which are ‘scattered indiscriminately over the whole of the North European plain’ (Clark 1936, 172). However, due to the isolated nature of this form of osseous material culture decoration within Britain, Clark was unable to draw any more meaningful parallels between the British examples and other sites, and only included them in his consideration of art on the basis of ‘conjecture’ (Clark 1936, 162).

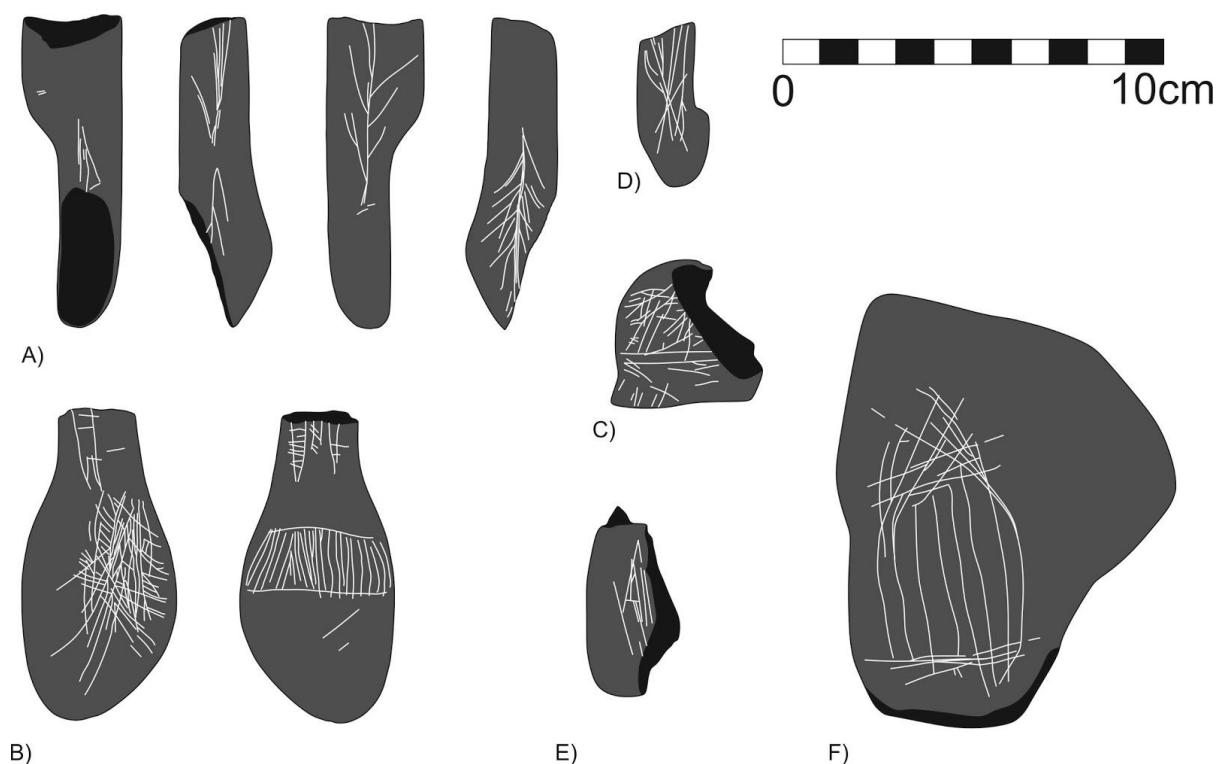


Figure 36: The Rhuddlan Incised Pebbles. (A) SF1; (B) SF2; (C) SF3; (D) SF4; (E) SF5; (F) SF6.

Berridge (Quinnell *et al.* 1994) provides some of the most detailed and direct discussion of the artwork from Rhuddlan, linking the finds from secondary deposits with an example from a dated Mesolithic context through the microscopic study of the methods of decoration (Figure 36). He notes that two distinct clusters of incised lines on SF1 and SF2 can be considered as ‘motifs’ for the sake of analysis - and that the form of these motifs have very close parallels elsewhere in Mesolithic Europe. He contests Miles’ (Miles 1972) earlier suggestion that, in its entirety, SF2 can be interpreted as an anthropomorphic figure with clothes, as this bucks the broader trend of Northwest European Mesolithic art. This interpretation requires a consideration of the overall form of the pebble as well as the separate motifs working together to form a complete, stylised figure - two characteristics which are deemed atypical of the wider body of Mesolithic artwork. Jacobi (in Quinnell *et al.* 1994) tentatively suggests that the shape depicted on SF6 may reference a fish trap, and notes the strong formal similarity between this specific design and the structure of wooden fish traps from the Late Mesolithic sites of Lille Knabstrup and Nidløse, Zealand in Denmark.

Clarke *et al.* (2012) provide a methodical discussion of a series of lines incised along the edges of a bevelled pebble tool from Camas Daraich, Skye. They note the lack of similarities between the form of the incisions and the more widely recognised net patterns, zoomorphs or anthropomorphic figures observed elsewhere in European Mesolithic artwork. They also note that the lines are unlikely to communicate individual ownership, as these areas would be covered and thus invisible if the object

were hafted or bound. Instead, they lean towards the incisions being representations of binding; guides for where and how an object should be bound which serve a quasi-functional purpose in providing purchase for binding materials. Whilst this interpretation is presented tentatively, Clarke *et al.* (2012) note the lack of discussion of many of these themes within broader discourses of the British Mesolithic.

6.3. The Star Carr pendant in the context of the European evidence

The Mesolithic art found so far in Britain has been created by incision, probably with a sharp piece of flint, possibly with the tip of a microlith or bladelet. Two pieces are incised on bone and antler but the majority are incised on stone, mainly pebbles. It is noteworthy that art also appears in caves in Britain, in the form of lines. The lines of the Star Carr pendant are unlike any other examples from Britain in that they appear more formally executed, with carefully patterned small lines running tangential to some of the longer lines. This is a pattern also found on examples from Denmark and perhaps strengthens the argument made for other 'Maglemosian' type artefacts, such as the amber pendant, barbed points and headdresses, recovered from Star Carr, that there was a strong connection over long distances at this time. What is particularly noteworthy is that pendants with the barbed line motif mostly have a western distribution (Toft and Brinch Petersen forthcoming) suggesting specific connections around the North Sea, or Doggerland region (Vang Petersen forthcoming).

This artefact is unique in a British context in that it can be classed as a decorated pendant due to the perforation, rather than a pebble. In this respect, it is very similar to a number of the northern European examples. Unlike those in Denmark which tend to be crafted from amber, this example stands out due to it being made from shale. It is also one of the few decorated pendants which have been found within an archaeological context and not as a stray find.

In summary, this example of Mesolithic art has some similarity to other pieces from Britain in that lines have been engraved, but in fact, it is much more similar to the Danish examples in terms of the barbed line patterning and the object itself. It is the earliest known Mesolithic art in Britain, dating to about 9000 BC and is therefore likely to be at least 500 years earlier than the following examples from Nab Head and Aveline's Hole.

7. The biography of the pendant

The pendant has been crafted out of a piece of shale, probably utilising the natural form of the pebble, as opposed to being worked into its current shape. No manufacturing traces were visible on the surface or edges, but given the PDSM discussed above, these may no longer be visible. Pieces of shale of varying shapes

are found locally both at the coast and closer to the lake eroding out of the underlying glacial till in ditches and river banks. There is of course the possibility that the shale pendant was brought to Star Carr from further afield.

One of the unresolved questions concerns the precise point at which the perforation was made: was it the first modification to this piece of shale or one of the last? The argument for the first phase comes from the logic that the artwork respects the placing of the hole and that a hole is likely to have been made first because of the possibility of breaking the object during the perforation process.

There is tentative evidence that the pendant was used; however, the microwear evidence is inconclusive, though a slightly brighter area on vertex may be indicative of it having been strung. We cannot rule out that this pendant was worn, but either for such a short duration of time that no wear traces developed, or that they have since been obscured by PDSM. The lines themselves are very faint and there is no evidence that they were accentuated with colour. This may indicate that the engravings were not intended to be clearly visible.

The engravings suggest two possible phases with two different types of markings. It is impossible to say how long the process of engraving took and how many people may have added to it. There could, for example, be at least two hands at work producing the two distinctive sets of lines: maybe members of the same social group, maybe friends, or maybe even different members of the same family. Similarly, what these lines mean is open to speculation. Different interpretations from those who have seen it have included a tree, a map, a leaf, tally marks, even a representation of the wooden platforms which have been found at Star Carr. Why *this* particular piece of shale was decorated in the first place is also an interesting question when other stone beads at Star Carr and more broadly across Britain are not decorated.

The other noteworthy mark on the artefact is the nick on the non-engraved side. There is no visible evidence for how it was made though it must have been made by some form of percussion (Peter Rawson personal communication 2015), either accidental damage, or perhaps deliberately damaged prior to deposition in this context (Toft and Brinch Petersen forthcoming). However, it may also date to before the raw piece of shale was collected and turned into a pendant. It is likely that the nick was made before, or at the moment that, the pendant was deposited in the lake edge deposits, evidenced by the clustering of iron pyrite which has probably accumulated within this feature since deposition into the peat.

Finally, it is impossible to say who made, possibly wore, then deposited this pendant. It is noteworthy that the bead comes from an atypical context which has produced significant numbers of antler frontlets, also termed headdresses, interpreted to have

been used by shamans. One possibility is that this pendant was also part of ritual paraphernalia used by a shaman, or considered to be some sort of amulet (e.g. Clark 1936; Vang Petersen forthcoming). It is also possible that it was deposited intentionally into the lake as a way of ending its use life, as has been suggested for Danish pendants (Toft 2009; Van Petersen forthcoming).

8. Conclusions

Through integrating a broad variety of scientific and imaging techniques to study this engraved pendant, displaying the earliest recorded art in Mesolithic Britain, we have developed an in-depth understanding of its likely source, production, method of engraving, and its depositional context. Detailed insights into the phasing of the lines engraved across its surface allow us to consider the temporality and compositional planning involved in the production of the art.

A battery of scientific methods were used to detect any residues which may have been applied to enhance the engraving. This work revealed that no such residues were applied, or at least, have not survived. What it did show was that pyrite, sand and micro-organisms identified during the analyses can be attributed to the pendant's depositional context. Because of the bright sheen produced by pyrite and PDSM, use-wear analysis was unable to provide definitive evidence that it had been strung, but considering how unique and symbolic an object this is, it may only have been worn for a special occasion, leaving no detectable wear traces. This interpretation may have resonance with the possibility that design was engraved in a short period of time, and the unusual context in which it was found. In this case, it is possible to consider the making, use and deposition of this object happening in quick succession. A further curiosity is the nick on the non-engraved surface. We have been unable to determine whether this was made intentionally but the presence of pyrite within the nick demonstrates that it happened in antiquity.

On contextualising the art on the Star Carr pendant within the broader evidence for art in Mesolithic Britain and Denmark, the latter producing the largest collection of Mesolithic art in Europe, we discovered that both the engravings - in particular the distinctive barbed lines of Clark's type C - and the choice of pendant form are closely aligned with what is known from southern Scandinavia. However, it is important to acknowledge that despite the broad spectrum of scientific analyses applied to this object, revealing new and unprecedented insights into its making, some artefacts will remain enigmatic; we can only speculate as to what the art represents, and what the production and possibly wearing and display of this object meant to the people living along this lake edge during the ninth millennium BC.

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